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Indian Standard

METHOD FOR DETERMINATION OF THERMAL CONDUCTIVITY OF FOODGRAINS

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 11 December 1978, after the draft finalized by the Storage Structures and Storage Management Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 In order to calculate the temperature changes in a grain bin due to fluctuation in external and internal temperatures and to predict the temperature variations within a grain mass during drying or to determine heat flow rate, it is essential to determine thermal conductivity of grains.

0.3 Because of the different methods used by agricultural scientists, it is not possible to have reproducible figures of the thermal conductivity of various grains. This standard, therefore, prescribes a method for measuring the thermal conductivity of grains. Adoption of this standard, thus, would enable the compilation of data from all research workers on a uniform basis.

0.4 Appendix A gives for guidance some of the observed values of thermal conductivity for the convenience of the design engineers.

0.5 In the preparation of this standard, considerable help has been provided by the Department of Processing and Agricultural Structures, College of Agricultural Engineering, Punjab Agricultural University, Ludhiana.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes a method for determination of thermal conductivity of foodgrains.

*Rules for rounding off numerical values (*revised*).

2. APPARATUS

2.1 The apparatus having the following assembly shall be used (*see* Fig. 1).

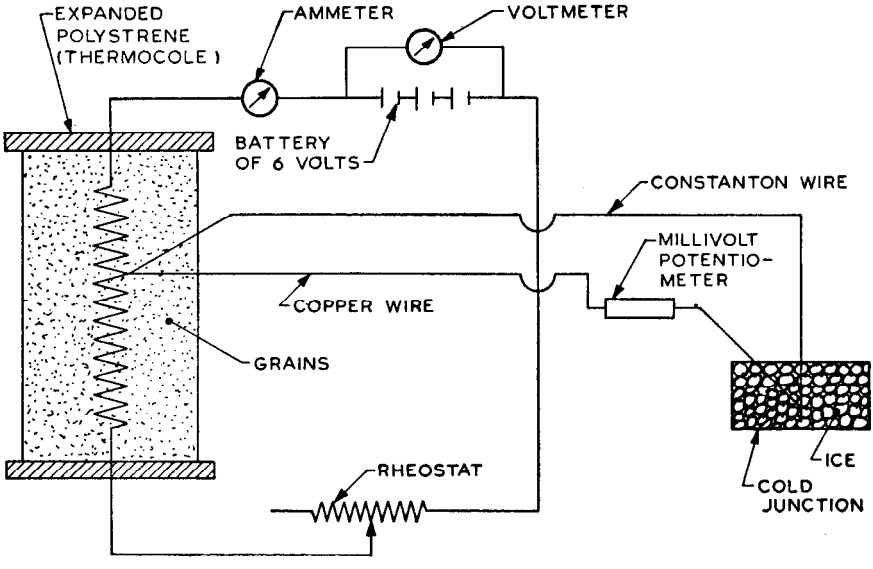


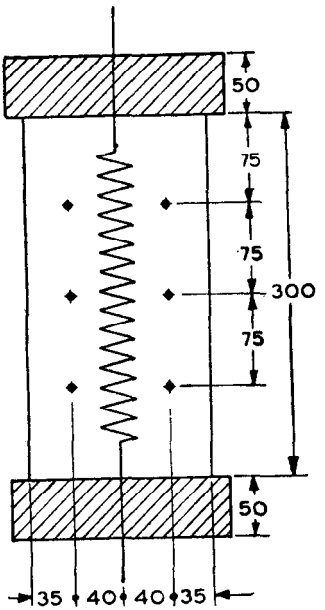
FIG. 1 APPARATUS FOR DETERMINATION OF THERMAL CONDUCTIVITY

2.1.1 The apparatus consists of a hollow brass cylinder of 300 mm depth and 150 mm diameter. A bare resistance heating wire of known resistance and 200 mm length is stretched between copper leads along the axis of the cylinder. A rheostat should be used to control the flow of current in the circuit. Both ends of the test cylinder should be insulated with 50 mm thick expanded polystrene (thermocole) sheets. Nine calibrated copper-constanton thermocouples with cold junctions maintained at 0°C should be placed in the test cylinder as shown in Fig. 2.

3. TEST SAMPLE

3.1 The grain of which thermal conductivity is to be determined shall be properly cleaned so that it does not have refractions [*see* IS : 4333 (Part I)-1967*] more than 0·5 percent. It should also be free from insect pests.

*Method of analysis of foodgrains: Part I Refractions.



All dimensions in millimetres.

FIG. 2 LOCATION OF THERMOCOUPLES IN TEST-CYLINDER

3.2 The foodgrain shall be of the same variety.

3.3 The moisture of the foodgrain should be measured in accordance with IS : 4333 (Part II)-1967* and stated in the test report.

4. PROCEDURE

4.1 Close the circuit and adjust the current to one ampere by the help of the rheostat. Open the circuit. Fill the test cylinder of the conductivity apparatus with the grains. Do not compact the grains in the cylinder. Close the circuit and record the temperature after one minute and ten minutes of closing circuit. Take such temperature readings for all the nine thermocouples, preferably by a multi-point temperature recorder.

4.2 A thermal conductivity value is valid only for one particular moisture content of foodgrain. To find out the range of thermal conductivity

*Method of analysis of foodgrains: Part II Moisture.

value, tests should be performed on foodgrain moistures varying from 5 percent (wet basis) to 30 percent (wet basis). Thermal conductivity values have linear relationship with moisture content of foodgrains.

5. CALCULATION

5.1 Calculate the thermal conductivity of the foodgrains at nine different places by using the following formula and take average of these nine values:

$$K = \frac{0{\cdot}238\,9\ I^2 R\ l_n\ (t_2/t_1)}{4\pi\ (T_2 - T_1)}$$

where

K = thermal conductivity in cal/cm s deg C,

I = current in amperes,

R = resistance of heating wire in ohms/cm length,

T_1 = temperature in °C at time t_1 minutes after closing the circuit,

T_2 = temperature in °C at time t_2 minutes after closing the circuit, and

l_n = natural log.

5.2 Express the result as cal/cm s deg C.

NOTE — 1 cal/cm s deg C = 4·186 8 W/cm deg C

or

1 W/cm deg C = 0·238 846 cal/cm s deg C.

6. TEST REPORT

6.1 The test report should indicate all the characteristics of the grain (*see* **3**) and whether the grain has been graded or not before undertaking the measurement of thermal conductivity.

APPENDIX A

(*Clause* 0.4)

VALUES OF THERMAL CONDUCTIVITY OF WHEAT, MAIZE AND PADDY

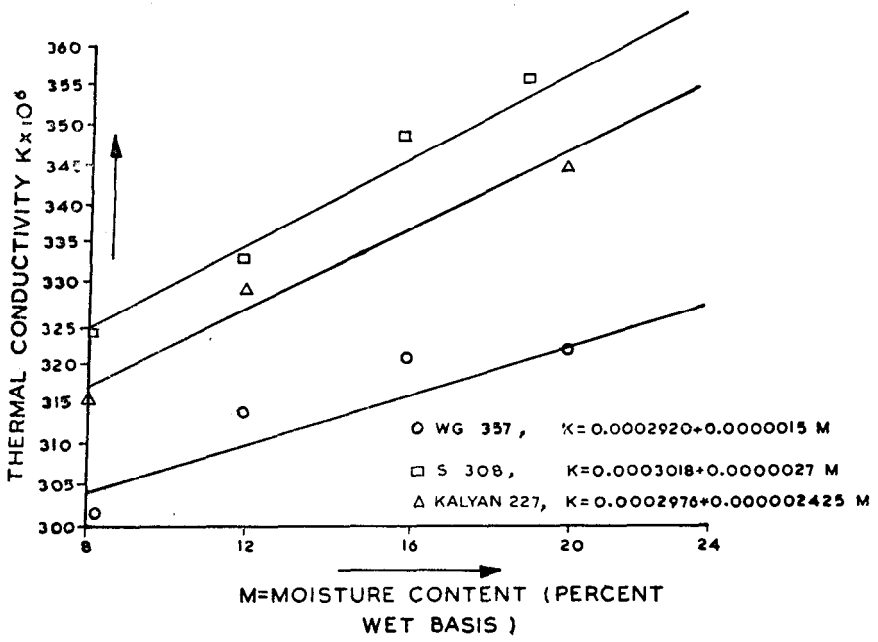


FIG. 3 THERMAL CONDUCTIVITY OF WHEAT IN cal/cm² s deg C/cm

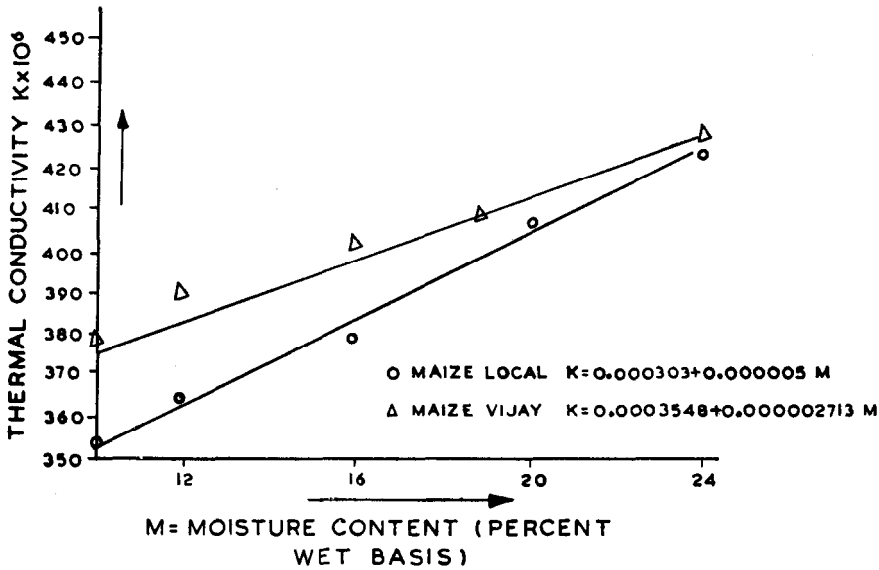


FIG. 4 THERMAL CONDUCTIVITY OF MAIZE IN cal/cm² s deg C/cm

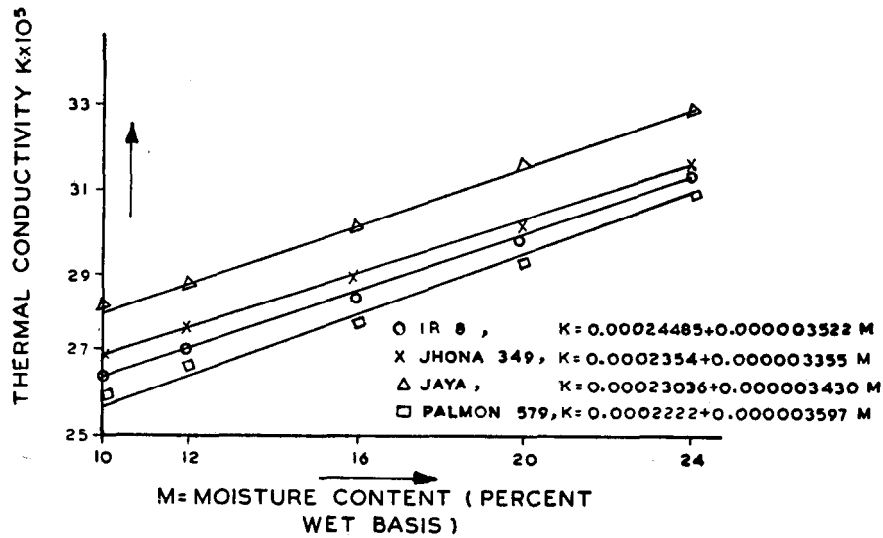


FIG. 5 THERMAL CONDUCTIVITY OF PADDY IN cal/cm² s deg C/cm